

INDOOR AIR QUALITY ASSESSMENT

**Country Elementary School
Alphabet Lane
Weston, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
July 2004

Background/Introduction

At the request of the Weston Public School Department (WPSD) and their consultant Carlisle Consulting Group, Inc. (CCGI), the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Country Elementary School (CES), Alphabet Lane, Weston, Massachusetts. The request was prompted by concerns about general indoor air quality, temperature control and odors.

On April 27, 2004, a visit to conduct an indoor air quality assessment was made to this school by Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Neil Foley, Partner, CCGI during the assessment. The school had previously been visited by BEHA staff in July of 2003, while the building was undergoing construction/renovations. A report was issued detailing indoor air quality conditions in the school at that time (MDPH, 2003). A general IAQ assessment was conducted due to the completion of demolition/building renovations.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). BEHA staff also performed visual inspection of building materials

for water damage and/or microbial growth. Moisture content of building materials was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The CES houses approximately 400 students in kindergarten through third grade and a staff of approximately 65. The tests were taken during normal operations at the school. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in two of twenty-two areas surveyed, indicating adequate ventilation in most of the areas surveyed. It is important to note however, some classrooms were sparsely populated and/or had open windows, which can greatly reduce carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 1) and return air through an air intake located at the base of each unit ([Figure 1](#)). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. All univents in areas surveyed were operating, however, obstructions to airflow, such as items stored on univents and furniture near univent return vents were seen in a number of classrooms (Picture 2).

The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents connected to rooftop motors. This system was operating during the assessment. However, the location of some exhaust vents near hallway doors can limit exhaust efficiency when classroom doors are open (Picture 3). When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

Fresh air in interior areas, offices and specialty rooms is provided by rooftop air-handling units (AHUs) and ducted to classrooms via ceiling-mounted air diffusers. Return air is drawn into wall or ceiling vents back to the AHUs. These systems were functioning during the assessment. It is important to note that one week prior to this BEHA assessment, Thompson Consultants, Inc. (TCI), the school's mechanical ventilation consultant, made repairs to one of the rooftop AHUs (AHU #4). The air intake damper for this AHU had been shut, therefore no mechanical means of fresh air had been provided to these areas prior to the repairs. These areas had been the loci of many of the occupants' comfort and odor complaints. Without proper supply and exhaust ventilation, indoor air pollutants can build up, leading to indoor air quality/comfort complaints. TCI personnel also found loose fan belts in AHU #4, which may have accounted for the burning odors reported by school staff. TCI reportedly changed and adjusted these fan belts (TCI, 2004). No re-occurring odors have been reported from school staff since these repairs.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to

provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994). Balancing of these systems was conducted by TCI in April of 2004 (TCI, 2004). It is also important to note that the HVAC systems are controlled by a central computer terminal. At the time of the assessment, BEHA staff recommended that training be provided to multiple individuals to ensure proper operation and maintenance of the HVAC system. In subsequent correspondence with school officials, it was reported that such training is planned (CES, 2004).

The Massachusetts Building Code requires that each classroom have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air (20 cfm in offices) or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see [Appendix A](#).

Temperature measurements ranged from 70° F to 75° F, which were within the BEHA recommended comfort range the day of the assessment. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. It is also difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., AHU louvers shut, univents obstructed). Occupants reported on-going heat complaints near the second floor atrium. These heat complaints were documented in the previous BEHA assessment (MDPH, 2003), and appears to result from a lack of louvered grates on the terminus of the ductwork. Without louvered vents to direct air downward (to warm incoming occupants) the ducts force hot air straight across the lobby toward occupied areas on the second floor.

The relative humidity measured in the building ranged from 30 to 55 percent, which was below the BEHA recommended comfort range in some areas the day of the assessment. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. The sensation of dryness and irritation is common in a low relative humidity environment.

Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. In general, materials that are prone to mold growth can become colonized when moistened for more than 24 to 48 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in a large number of schools and buildings were moistened for an extended period of time. The CES reportedly experienced mold growth in carpeting in several classrooms. The WPSD hired Environmental Health & Engineering (EH&E), an environmental consultant, to conduct mold sampling. For classrooms with elevated spore levels, EH&E recommended that carpeting be sprayed with an encapsulant and removed (EH&E, 2003). A second consultant, Simpson Gumpertz & Heger Inc. (SGH), conducted further mold and moisture sampling. SGH recommended that 1) dehumidifiers be employed during summer months to prevent elevated moisture levels and condensation; 2) all carpeted areas be replaced with non-porous material; and 3) non-porous surfaces be cleaned regularly to prevent the build-up of dust and debris that could serve as a mold growth medium (SGH, 2003).

BEHA staff were asked to examine room C-109 for signs of water damage and/or microbial growth. In an effort to ascertain moisture content of building materials in this area, readings were taken in materials that would most likely be impacted by water penetration.

Building materials tested included ceiling tiles, gypsum wallboard and wood near exterior walls/windows. Moisture readings from similar building materials located on non-exterior walls were measured for comparison. The Delmhorst probe is equipped with three lights as visual aids to determine moisture level. Readings that activate the green light indicate a sufficiently dry or low moisture level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. No elevated moisture readings were measured during the assessment.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Signs of bird roosting and nesting were observed in a number of recesses around the exterior of the building (e.g., overhangs, building envelope penetrations) (Pictures 4 and 5). Birds can be a source of disease, and bird wastes and feathers can contain mold, which can be irritating to the respiratory system.

Certain molds are associated with bird waste and are of concern for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird rearing setting. While immune-compromised individuals have an

increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods employed for cleaning of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine whether the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989). Mr. Foley reported that Waltham Chemical, a pest control/management firm, was hired to remove bird nests and temporarily seal roosting areas with foam sealant. The WPSD and CCGI were also working with the architect and general contractor to permanently seal breaches in the building envelope.

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the “cleaner” is required to be trained in the use of personal protective methods and equipment to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals. In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or

the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. Given that containment procedures warranted are similar to those used to contain the spread of renovation-generated dusts and odors in occupied areas, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995). A copy of an issue of the *Centers for Disease Control Morbidity and Mortality Weekly Report* for July 10, 1998, which covers the clinic aspects as well as clean up associated with bird waste, is included as [Appendix B](#).

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM_{2.5}) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM_{2.5}.

Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide

level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. *Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND.

The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM₁₀). According to the NAAQS, PM₁₀ levels should not exceed 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in a 24-hour average (US EPA, 2000). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and

BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM_{2.5} standard requires outdoor air particulate levels be maintained below 65 µg/m³ over a 24-hour average (US EPA, 2000). Although both the ASHRAE standard and BOCA Code adopted the PM₁₀ standard for evaluating air quality, BEHA uses the more protective proposed PM_{2.5} standard for evaluating airborne particulate matter concentrations in the indoor environment. Outdoor PM_{2.5} concentrations were measured at 22 µg/m³ (Table 1). PM_{2.5} levels measured indoors were below outdoor levels (Table 1). Frequently, indoor air levels of particulates (including PM_{2.5}) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of TVOCs may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, TVOC air measurements reported are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While TVOC levels were ND, materials containing VOCs were present in the school. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Accumulated dry erase particulate was noted in some classrooms, which can also serve as a source of airborne particulates.

Several other conditions that can affect indoor air quality were noted during the assessment. A number of exhaust/return vents were noted with accumulated dust (Picture 6). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Several rooms had missing and/or dislodged ceiling tiles (Picture 7). Missing/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors.

Finally, periodic sewer gas odors were reported in the nurse's suite. The floor in this area contains a drain (Picture 8). Drain traps are designed to form a water seal to prevent the backup of sewer odors. Without frequent input of water, the airtight seal on the trap can be breached resulting in the back up of sewer gas into occupied areas. Sewer gas can create nuisance odors and be irritating to certain individuals.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Continue working with contractors and pest management consultants to remove birds' nests and wastes from the building. To prevent possible exposure to bird wastes, implement the corrective actions recommended by the CDC (CDC, 1998). To prevent possible spread of bird waste particulates to occupied areas, employ the methods listed in the SMACNA guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).
2. Continue working with the school's HVAC consultant to determine further enhancements and monitor HVAC equipment for proper function and temperature control.
3. Develop a notification system for building occupants to report ventilation/comfort complaints.
4. Continue with plans to provide training to multiple individuals to ensure proper operation and maintenance of the HVAC system.
5. Operate both supply and exhaust ventilation continuously, independent of classroom thermostat control, during periods of school occupancy to maximize air exchange.
6. Consider reconfiguring classrooms as necessary to facilitate air exchange between univents and exhaust vents. Ensure classroom doors are closed to maintain ceiling-mounted exhaust vent function.
7. Ensure ventilation equipment is properly balanced. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).

8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
9. Clean exhaust/return vents periodically to prevent excessive dust build-up.
10. Replace missing/damaged ceiling tiles.
11. Pour water down floor drain in nurse's suite regularly (once/twice per week) to maintain water trap seal.
12. Consider adopting the US EPA document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at <http://www.epa.gov/iaq/schools/index.html>.
13. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Materials are available at the MDPH's website: <http://www.state.ma.us/dph/beha/iaq/iaqhoFtme.htm>.

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Picture 1



Univent Fresh Air Intake

Picture 2



Furniture Configured around Univent Obstructing Airflow into Return Vent

Picture 3



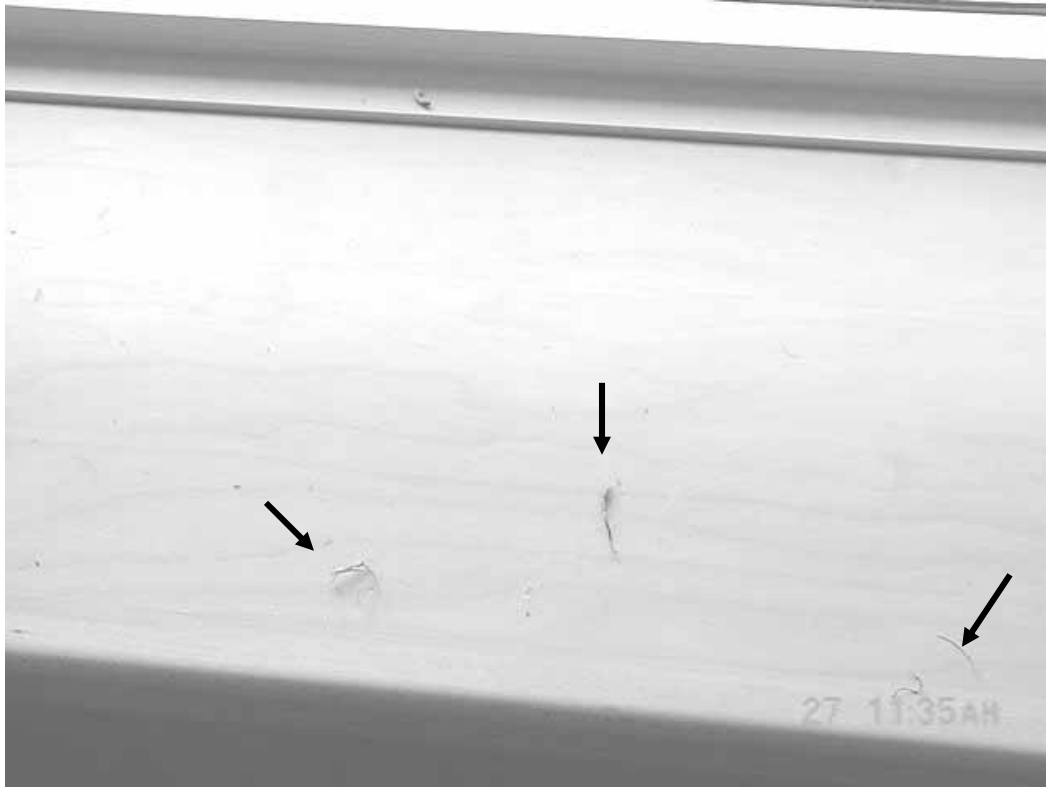
Location of Classroom Exhaust Vent near Open Hallway Door

Picture 4



Interior View (from Cafeteria) of Area of Bird Ingress

Picture 5



**Bird Feathers and Nesting Materials on Windowsill in Cafeteria
Beneath Area Shown in Picture 4**

Picture 6



Dirt/Dust Accumulation on Exhaust Vents

Picture 7



Missing Ceiling Tile in Classroom

Picture 8



Floor Drain in Nurse's Suite

Weston Country Elementary School
Alphabet Lane, Weston, MA 02493

Table 1

Indoor Air Results
April 27, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbo n Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background (outdoors)	59	57	383	ND	ND	22			-	-	Cloudy, intermittent sunshine, winds light & variable
A-116 Computer Room	73	44	649	ND	ND	15	27	N	Y Ceiling	Y Ceiling	DEM
B-124	70	47	488	ND	ND	17	2	Y	Y Univent	Y Wall	Cleaners, 20 Occupants gone 10 min.
B-200	74	42	650	ND	ND	21	~20	Y	Y Univent	Y Ceiling	DEM; hallway door open
B-209	75	37	613	ND	ND	16	22	Y	Y Univent	Y Ceiling	DEM; hallway door open; supply blocked by furniture
B-218	75	35	675	ND	ND	15	23	Y	Y Univent	Y Ceiling	DEM, hallway door open;
C-102	72	38	684	ND	ND	19	19	Y	Y Univent	Y Ceiling	DEM, turtle; hallway door open

ppm = parts per million

µg/m3 = micrograms per cubic meter

AD = air deodorizer

AP = air purifier

aqua. = aquarium

AT = ajar ceiling tile

BD = backdraft

CD = chalk dust

CP = ceiling plaster

CT = ceiling tile

DEM = dry erase materials

design = proximity to door

FC = food container

G = gravity

GW = gypsum wallboard

M = mechanical

MT = missing ceiling tile

NC = non-carpeted

ND = non detect

PC = photocopier

PF = personal fan

plug-in = plug-in air freshener

PS = pencil shavings

sci. chem. = science chemicals

TB = tennis balls

terra. = terrarium

UF = upholstered furniture

WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1-1

Weston Country Elementary School
Alphabet Lane, Weston, MA 02493

Table 1

Indoor Air Results
April 27, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbo n Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
C-105	71	38	500	ND	ND	12	0	Y	Y Univent	Y Ceiling	DEM; hallway door open; supply blocked by furniture
C-107	71	43	919	ND	ND	17	17	Y	Y Univent	Y Ceiling	DEM, clutter
C-108	70	53	483	ND	ND	15	0	Y	Y Ceiling	Y Wall	
C-109	71	48	509	ND	ND	14	4	Y	Y Ceiling	Y Wall	5 individuals using DEM, odors; Draft complaints, low moisture content wood/GW around windows/frames
C-111	71	55	459	ND	ND	12	0	Y	Y Ceiling	Y Wall	
C-112	71	48	512	ND	ND	14	2	N	Y Ceiling	Y Wall	DEM, 3 occupants gone 5 min
C-113	73	39	895	ND	ND	16	19	Y	Y Univent	Y Ceiling	DEM; hallway door open; supply blocked by clutter

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1-2

Weston Country Elementary School
Alphabet Lane, Weston, MA 02493

Table 1

Indoor Air Results
April 27, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbo n Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
C-201	73	38	505	ND	ND	16	3	Y	Y Univent	Y Ceiling	Photocopier, recommend moving photocopier under ex vent; hallway door open; supply blocked by furniture
C-202	73	40	701	ND	ND	18	24	Y	Y Univent	Y Ceiling	DEM, pets, garbage can on uv air diffuser; upholstered furniture; supply blocked by furniture
C-202	73	38	565	ND	ND	18	1	Y	Y Univent	Y Ceiling	DEM, cleaners, hallway door open; ~21 OCL done 5 min., supply blocked by furniture, exhaust occluded by dirt/debris.
C-209	72	36	419	ND	ND	13	0	Y	Y Ceiling	Y Wall	DEM; Hallway door open;
C-211	72	30	460	ND	ND	12	2	Y	Y Ceiling	Y Wall	DEM
Cafeteria	71	42	546	ND	ND	16	~50	Y	Y Ceiling	Y Wall	Hallway door open; breaches in building envelope, nest material & bird waste along

ppm = parts per million

µg/m3 = micrograms per cubic meter

AD = air deodorizer

AP = air purifier

aqua. = aquarium

AT = ajar ceiling tile

BD = backdraft

CD = chalk dust

CP = ceiling plaster

CT = ceiling tile

DEM = dry erase materials

design = proximity to door

FC = food container

G = gravity

GW = gypsum wallboard

M = mechanical

MT = missing ceiling tile

NC = non-carpeted

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PC = photocopier

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Comfort Guidelines

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1-3

Weston Country Elementary School
Alphabet Lane, Weston, MA 02493

Indoor Air Results
April 27, 2004

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
											windowsill
Library	72	45	565	ND	ND	14	25	Y	Y Ceiling	Y Wall	Missing ceiling tiles in office
Main Office	74	38	472	ND	ND	11	5	Y	Y	Y	Photocopier
Nurse	72	39	555	ND	ND	13	3	Y	Y ceiling	Y ceiling	Hallway door open; floor drain, periodic sewer gas odors, shower drain;

ppm = parts per million

µg/m3 = micrograms per cubic meter

AD = air deodorizer

AP = air purifier

aqua. = aquarium

AT = ajar ceiling tile

BD = backdraft

CD = chalk dust

CP = ceiling plaster

CT = ceiling tile

DEM = dry erase materials

design = proximity to door

FC = food container

G = gravity

GW = gypsum wallboard

M = mechanical

MT = missing ceiling tile

NC = non-carpeted

ND = non detect

PC = photocopier

PF = personal fan

plug-in = plug-in air freshener

PS = pencil shavings

sci. chem. = science chemicals

TB = tennis balls

terra. = terrarium

UF = upholstered furniture

WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%